PB-227 934

PHYSICAL DATA POTOMAC RIVER TIDAL SYSTEM INCLUDING MATHEMATICAL MODEL SEGMENTATION

Norbert A. Jaworski, et al

Federal Water Quality Administration
Annapolis, Maryland

1969

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Chesapeake Technical Support Laboratory
Middle Atlantic Region
Federal Water Quality Administration
U. S. Department of the Interior

PHYSICAL DATA
POTOMAC RIVER TIDAL SYSTEM
INCLUDING MATHEMATICAL MODEL
SEGMENTATION

Technical Report No. 43

Norbert A. Jaworski
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INTRODUCTION

In its continuing water quality studies of the Potomac, the Chesapeake Technical Support Laboratory (CTSL) found it necessary to systematically and accurately define the physical characteristics of the estuary. Factors of major importance are: surface and cross-sectional areas, volumes, and distances between bridges, buoys, prominant landmarks and other reference points. This type of data is not only essential for mathematical modeling studies but also to interpret field survey information.

River mileages were measured along the main channel using a set of dividers on U.S. Geological Survey 7.5 minute quadrangle maps. For convenience, all distances were measured from Chain Bridge rather than from a reference point at the mouth of the Potomac. A reference point at the confluence of the Potomac with the Chesapeake Bay was established (See Figure II). Uniform river mile locations using statute miles were determined for the primary sampling stations, landmarks, navigation buoys, etc., and are presented in this report.

Cross-sections were plotted at intervals from 0.5 to 3.0 miles from soundings shown on U.S. Coast and Geodetic Survey charts and the plots planimetered to determine cross-section areas. Surface areas were also planimetered directly from USC&GS charts. Segment volumes were obtained by multiplying the average cross-sectional areas by the length.

Although much of the data presented in this report applies to a predetermined segmentation for mathematical model studies, it is general in nature and thus adaptable to other needs. Hopefully, these basic data will be used by other agencies involved with the Potomac Estuary to eliminate duplication of effort.

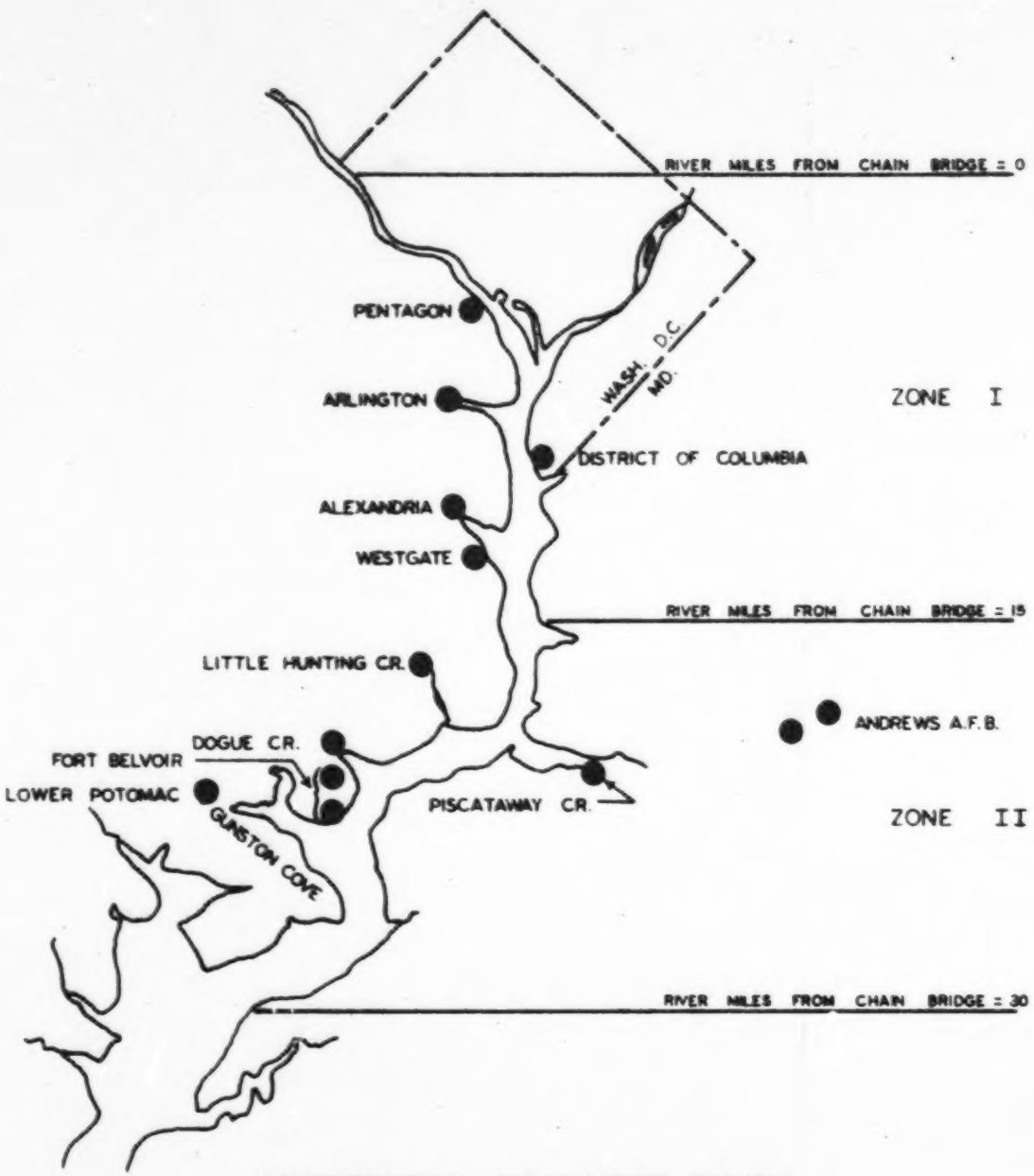
GENERAL DESCRIPTION OF THE POTOMAC RIVER TIDAL SYSTEM

The Potomac River basin is the second largest watershed in the Middle Atlantic States. Its tidal portion begins at Little Falls in the Washington metropolitan area and extends 114 miles southeastward to the Chesapeake Bay.

The tidal portion is several hundred feet in width at its head at Washington and broadens to nearly six miles at its mouth. A shipping channel with a minimum depth of 24 feet is maintained upstream to Washington. Except for this channel and a few short reaches where depths up to 100 feet can be found, the tidal portion is relatively shallow with an average depth of about 18 feet.

The mean tidal range is about 2.9 feet in the upper portion near Washington and about 1.4 feet near the Chesapeake Bay. The lag time for the tidal phase between Washington and the Chesapeake Bay is about 6.5 hours.

Effluents from twelve major wastewater treatment plants, with a thirteenth under construction, serving a population of about 2,500,000, are discharged into the upper tidal system. The locations of the discharges from these treatment facilities are shown in Figure I and presented in Table I.



WASTEWATER DISCHARGE ZONES

UPPER POTOMAC TIDAL RIVER SYSTEM

FIGURE I

TABLE I

Major Wastewater Discharge Locations
Upper Potomac Estuary

Facility	Receiving Stream	Distance from Chain Bridge	Expanded Thomann Model Segment	FWQA Model Segment
Combined D.C. system sewer overflow	Potcmac Estuary	4.0	4	5
Pentagon	Potomac Estuary	5.8	6	7
Arlington	Four Mile Run		12	78
District of Columbia	Potomac Estuary	10.4	13	129
Alexandria	Hunting Creek	12.4	15	81
Fairfax-West Gate	Hunting Creek Embayment	12.8	16	16
Piscataway	Piscataway Embayment	18.3	22	118
Andrews AFB No. 1	Piscataway Creek	18.3	22	118
Andrews AFB No. 2	Piscataway Creek	18.3	22	118
Fairfax Hunting Cr.	Little Hunting Creek	20.0	24	25
Fairfax Dogue Creek	Dogue Creek	22.5	27	84
Fairfax Lower Potomac	Pohick	24.5	28	128
Ft. Belvoir No. 1	Gunston Cove	24.5	28	85
Ft. Belvoir No. 2	Gunston Cove	24.5	28	85

* If discharge is into an embayment distance is to midpoint of embayment
All distances in statute miles

A. Reaches of Potomac River Tidal System

For discussion and investigative purposes, the tidal portion of the Potomac River was divided into three reaches as shown in Figure II and described below:

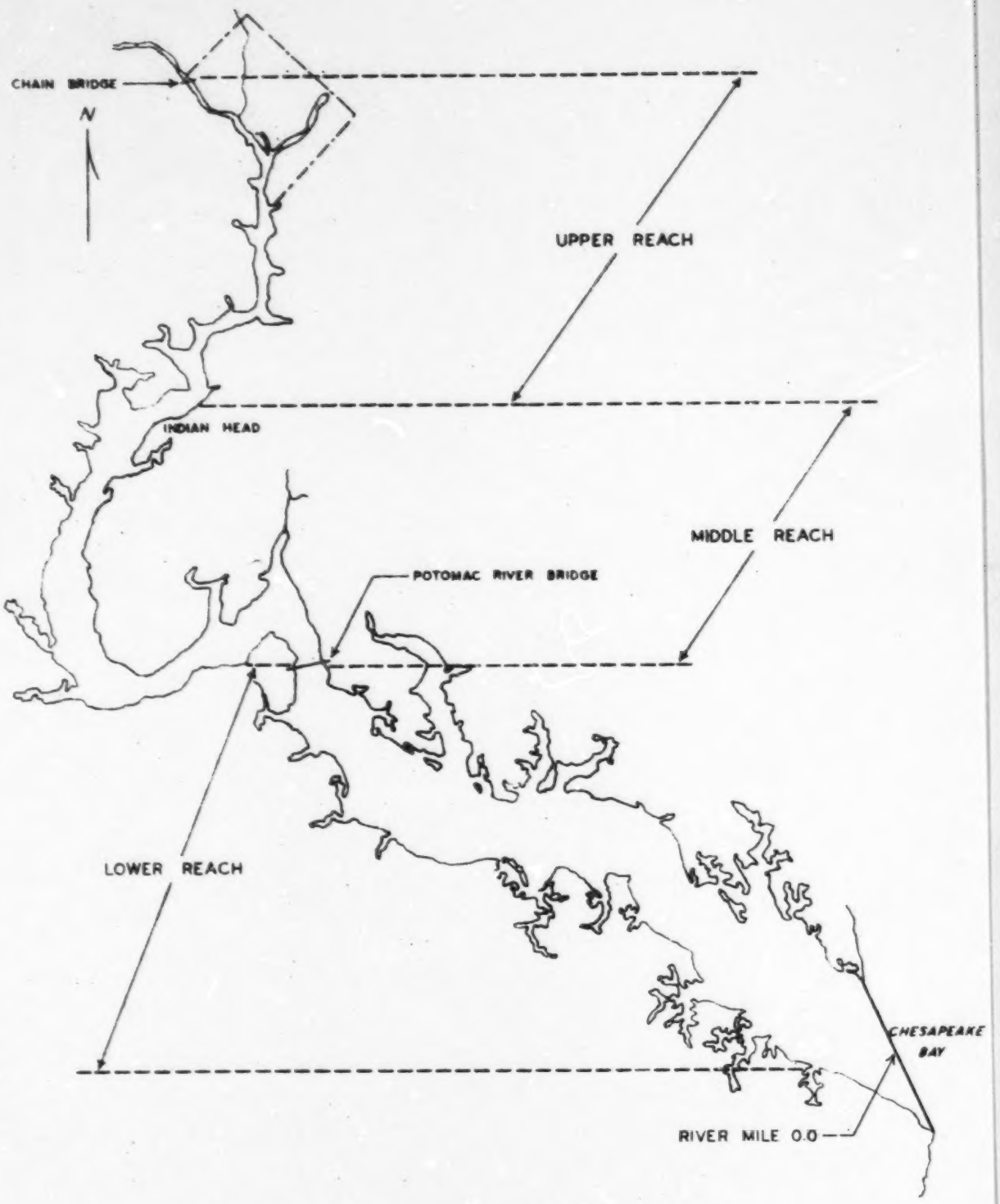
Reach	Description	River Miles	Volume $cu.ft. \times 10^8$
Upper	From Chain Bridge to Indian Head	114.4 to 73.8	93.50
Middle	From Indian Head to Rt. 301 Bridge	73.8 to 47.0	362.28
Lower	From Rt. 301 Bridge to Chesapeake Bay	47.0 to 00.0	1754.74

The upper reach, although tidal, contains fresh water. The middle reach is normally the transition zone from fresh to brackish water. In the lower reach, chloride concentrations near the Chesapeake Bay range from about 7,000 to 11,000 mg/l.

B. Zones of Upper Potomac Tidal System

To facilitate determination of water quality control requirements, the upper estuary was segmented by the CTSL into 15 mile zones beginning at Chain Bridge. Establishment of zones similar in physical characteristics allows flexibility in developing control needs. This zone concept was adopted by the conferees of the Potomac Enforcement Conference on May 8, 1969.

River mile distances from both the Chesapeake Bay and Chain Bridge for the upper three zones are given in Table II as well as in Figure II.



POTOMAC RIVER TIDAL SYSTEM

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FIGURE - II

TABLE II

ZONES OF UPPER POTOMAC ESTUARY

Zone and Description	River Mile of Upper End of Zone		River Mile of Lower End of Zone	
	from Chain Bridge	from Chesapeake Bay	from Chain Bridge	from Chesapeake Bay
I				
Chain Bridge to Broad Creek	0.0	114.4	15.0	99.4
II				
Broad Creek to Indian Head	15.0	99.4	30.0	84.4
III				
Indian Head to Maryland Point	30.0	84.4	45.0	69.4

MATHEMATICAL MODEL INVESTIGATIONS

Two approaches have been adopted to simulate water quality conditions in the Potomac Estuary. The first was the "average" tidal model developed by Dr. Robert Thomann at New York University. The second and the more recent approach is the FWQA Dynamic Estuary or "real time" tidal model originally developed by Water Resources Engineers of Walnut Creek, California under contract to U.S. Public Health Service, FWQA, and the State of California.

Details of both approaches have been adequately documented and are available from the authors or FWQA. A report comparing the two approaches in simulating the movement of pollutants in the Potomac Estuary is currently being prepared by CTSL.

Originally, the Potomac Estuary was divided into 28 segments for the Thomann Model. To add greater sensitivity in analyzing field data and reaction rates, the estuary divisions were further increased to 73 segments.

For the FWQA Model, three networks have been developed, one corresponding to the 73-segment FWQA Model with embayment segmentation added to give a total of 141 segments, and a detailed network of 766 segments.

In this report, segmentation data for both versions of the Thomann and the main stem of 73 node FWQA models were presented.

Detailed data on the other system are available from CTSL upon request. For the main Potomac, nodes for the FWQA Model were placed at the interfaces of the Thomann Model segments.

In Figures VII and VIII are exhibited the segmentation for the Thomann approach for the Anacostia and Potomac Tidal River Systems with Figure IX presenting a schematic of the FWQA Potomac Estuary Model. The lower 11 segments of the FWQA Model are not incorporated into the current working system.

DATA FORMAT

The remainder of this report presents the following:

A. Sampling Stations and Landmark Locations

Table		Number
1.	CTSL Sampling Stations	III
2.	D. C. Water Pollution Control Division Sampling Stations	IV
3.	Bridges	V
4.	Potomac Estuary Buoys to Reference Water Quality Sampling	VI
5.	Mileage Location of Prominent Reference Points along the Potomac Estuary	VII

Figure		
1.	Sampling Stations Potomac Estuary	III

B. Mathematical Model and Physical Data

Table		
1.	Thomann Model, Segment Geometry, Potomac Estuary Mean Low Water Data (Excluding Embayments)	VIII
2.	Thomann Model, Segment Geometry, Potomac Estuary Mean Water Data (Excluding Embayments)	IX
3.	Thomann Model, Segment Volumes (Including Embayments)	X
4.	Thomann Model, Revised Potomac Estuary Geometry for Expanded Segmented System, Mean Water Data (Excluding Embayments)	XI
5.	Mathematical Model Segmentation, Anacostia Tidal River System, Mean Water Data	XII

Table (continued)	Number
6. FWQA Network Data, Potomac Estuary (Excluding Embayments)	XIII
7. Embayment Data, Potomac Estuary	XIV
8. Mathematical Model Plotting Positions for the Potomac Estuary	XV

Figure	Number
1. Cumulative Surface Area Versus Distance, Potomac Estuary Mean High Water Data	IV
2. Cumulative Volume Versus Distance, Potomac Estuary Mean Water Data	V
3. Cross-sectional Area Versus Distance, Potomac Estuary Mean Water Data	VI
4. Thomann Mathematical Model Segments, Potomac Estuary	VII
5. Thomann Mathematical Model Segments, Anacostia Tidal River	VIII
6. Schematic of Potomac Estuary Network for the FWQA Dynamic Model	IX

TABLE III

CTSL SAMPLING STATIONS

Station Number	Location	Buoy Reference	Miles below Chain Bridge
1	Key Bridge		3.35
1A	Memorial Bridge		4.85
2	14th Street Bridge		5.90
2A	Potomac Park	N "6"	6.70
3	Hains Point	C "1" - N "4"	7.60
3A	Hunters Point	C "11" - C "9"	8.70
4	Bellevue	FLR - 23' Bell	10.00
4A	Goose Island	R "8" - N "6"	11.05
5	Woodrow Wilson Bridge		12.10
5A	Rosier Bluff	C "87"	13.55
6	Broad Creek	N "86"	15.20
7	Piscataway Creek	FL "77"	18.35
8	Dogue Creek	FL "67"	22.30
8A	Gunston Cove	R "64"	24.30
9	Hallowing Point	FL "59"	26.90
10	Indian Head	N "54"	30.60
10A	Occuquon Bay	N "52"	32.15
11	Possum Point	R "44"	38.00
12	Sandy Point	N "40"	42.50
13	Smith Point	N "30"	46.80
14	Maryland Point	G "21"	52.40

CTSL SAMPLING STATIONS

Station Number	Location	Buoy Reference	Miles below Chain Bridge
15	Nanjemoy Creek	N "10"	58.55
15A	Port Tobacco	C "3"	63.75
16	301 Bridge		67.40
17	Bluff Point or Stony Pt.	BW - MO(A) "H"	73.45
18	Colonial Beach/Kettle Bottom Shoals	FL "25"	76.60
19	Wicomico River	C "15"	82.00
20	Kingcopsico	BWN "52" B	90.25
21	Ragged Point	BW "51" B	95.42
22	Piney Point	FR "0" FR A	99.20
23	Point Lookout	FL "4" Bell	107.41
24	Smith Point	BWN "43" B	118.00
25	Point Lookout	BWN "57" B	114.85

TABLE IV

D. C. WATER POLLUTION CONTROL DIVISION
SAMPLING STATIONS

Station Number	Location	Buoy Reference	Miles below Chain Bridge
1	Chain Bridge		0.00
2	Fletcher's Boat House		1.40
3	Three Sisters Island	Sewer outlet	2.75
4	Roosevelt Island		4.25
5	Memorial Bridge		4.85
6	Highway Bridge		5.90
7	Potomac Park	N "6"	6.70
8	Hains Point	N "4" N "3"	7.20
9	Giesboro Park	N "11"	8.20
10	Above WPCP (Blue Plains)	FLR 4 sec "23"	10.20
11	Opposite WPCP " "	Sewer outlet	10.40
12	Below WPCP " "	N "8"	10.70
13	Woodrow Wilson Bridge		12.10
14	Ft. Foote	N "86" N "87"	14.45
15	Ft. Washington	C "79"	17.95
16	Marshall Hall	N "69"	21.80
17	Hallowing Point	FL "59"	26.90
18	Indian Head	N "54"	30.60
19	St. Neck	N "46"	35.20
20	Sandy Point	N "41"	42.50
21	Smith Point	N "30"	45.80
22	Maryland Point	G "21"	52.40

TABLE V

BRIDGES

Location or Name	Miles below Chain Bridge
Chain Bridge	0
Key Bridge	3.35
Theodore Roosevelt Bridge	4.45
Memorial Bridge	4.85
14th Street Bridges	
a. George Mason	5.90
b. Rochambeau	6.05
Woodrow Wilson Bridge	12.10
301 Bridge	67.40

TABLE VI

POTOMAC ESTUARY BUOYS USED
TO REFERENCE WATER QUALITY SAMPLING

Buoy	River Miles from Chain Bridge
N "12"	5.15
RN "10"	5.75
N "6"	6.70
C "1"	7.87
N "4"	7.20
C "3"	7.20
N "2"	7.72
C "11"	8.50
C "9"	8.95
C "1"	9.15
N "2"	9.25
23' Bell	10.01
R "8"	10.75
N "6"	11.30
N "4"	11.70
R "2"	13.05
C "87"	13.95
N "86"	14.95
R "84"	15.95
C "83"	17.13

POTOMAC ESTUARY BUOYS USED
TO REFERENCE WATER QUALITY SAMPLING (Cont.)

Buoy	River Miles from Chain Bridge
C "81"	17.40
C "79	17.95
FL "77"	18.50
C "75"	19.00
C "73"	19.90
FL "71"	20.90
C "69"	21.55
FL "67"	22.30
N "66"	23.05
R "64"	24.25
R "62"	24.90
C "61"	26.40
FL "59"	26.90
R "60"	27.00
C "57"	27.70
N "54"	30.60
N "52"	32.15
R "44"	37.90
N "40"	42.50
N "30"	45.80

POTOMAC ESTUARY BUOYS USED
TO REFERENCE WATER QUALITY SAMPLING (Cont.)

Buoy	River Miles from Chain Bridge
N "24"	50.20
G "21"	52.40
N "16"	55.00
N "10"	58.55
C "3"	63.75
FL "29"	70.65
BW MO(A) "H"	73.45
FL "25"	76.60
C "15"	82.00
BWN "52" B	90.25
BW SI B	95.42
FR "D" FR A	99.20
FL "4" Bell	107.41
BWN "57" B	114.85
BWN "43" B	118.00

TABLE VII

MILEAGE LOCATION OF PROMINENT REFERENCE POINTS
ALONG THE POTOMAC ESTUARY
(excluding those used as sampling stations)

Landmark Points	Miles below Chain Bridge
Marbury Point	10.55
Fox Ferry Point	7.50
Jones Point	12.34
Indian Queen Point	14.90
Hatton Point	17.30
Sheridon Point	18.65
Mockley Point	18.60
Bryan Point	19.80
Ferry Point	21.90
Whitestone Point	24.10
Pomonkey Point	26.40
Sycamore Point	29.80
High Point	31.30
Deep Point	34.00
Cockpit Point	35.90
Douglas Point	43.90
Simms Point	46.80
Marlboro Point	49.35
Blossom Point	59.10
Upper Cedar Point	60.10

MILEAGE LOCATION OF PROMINENT REFERENCE POINTS
ALONG THE POTOMAC ESTUARY
(excluding those used as sampling stations)

Landmark Points	Miles below Chain Bridge
Mathias Point	62.70
Persimmon Point	66.20
Lower Cedar Point	68.80
Stony Point	72.70
Swan Point	74.20
White Point	75.00
Gum Bar Point	76.00
Church Point	77.00
Cobb Point	80.25
Waterloo Point	84.30
Crunch Point	88.10
Ragged Point	95.40
Deep Point	102.80
Kitts Point	105.20
Lawson Point	106.60

Table VIII
THOMANN MODEL
SEGMENT GEOMETRY POTOMAC ESTUARY
MEAN LOW WATER DATA
(Excluding Embayments)

Segment Number	Interface Areas Upper ft^2	Interface Areas Lower ft^2	Length ft	Volume $ft^3 \times 10^8$	Accumulative Volume $ft^3 \times 10^8$	Surface Area $ft^2 \times 10^6$	Average Width ft	Average Depth ft
1	1,000	41,700	14,890	1.94	1.94	8.332	559	23.3
2	41,700	22,500	10,665	2.58	4.52	13.886	1,302	18.6
3	22,500	20,260	9,187	1.81	6.33	19.218	2,092	9.4
4	20,260	30,900	9,504	2.30	8.63	25.439	2,677	9.0
5	30,900	35,700	8,396	2.88	11.51	24.440	2,911	11.8
6	35,700	32,400	11,404	3.63	15.14	30.883	2,708	11.8
7	32,400	43,350	13,992	5.69	20.83	52.323	3,739	10.9
8	43,350	49,500	11,300	5.70	26.53	47.768	4,227	11.9
9	49,500	60,300	13,516	8.60	35.13	45.769	3,386	18.8
10	60,300	60,150	10,085	6.94	42.07	57.433	5,695	12.1
11	60,150	86,250	13,570	9.80	51.87	55.878	4,118	17.5
12	86,250	99,600	24,129	23.57	75.44	146.860	6,086	16.0
13	99,600	123,150	15,312	18.06	93.50	123.309	8,053	14.6
14	123,150	179,700	14,732	20.57	114.07	182.186	12,367	11.3
15	179,700	160,350	22,387	38.58	152.65	195.516	8,734	19.7
16	160,350	208,500	21,859	40.60	193.25	236.064	10,800	17.2
17	208,500	212,400	22,123	49.11	242.36	274.925	16,947	13.1
18	121,400	216,600	25,291	53.34	295.70	391.366	15,475	13.6
19	216,600	161,400	28,354	49.68	345.38	251.061	8,854	19.8
20	161,400	198,900	24,816	48.26	393.64	327.268	13,188	14.75
21	198,900	242,000	27,614	62.14	455.78	286.387	10,371	21.7

SEGMENT GEOMETRY POTOMAC ESTUARY (Cont.)
MEAN LOW WATER DATA
(Excluding Embayments)

Segment Number	Interface Areas Upper ft^2	Interface Areas Lower ft^2	Length ft	Volume $ft^3 \times 10^8$	Accumulative Volume $ft^3 \times 10^8$	Surface Area $ft^2 \times 10^6$	Average Width ft	Average Depth ft
22	242,000	463,320	32,103	110.90	566.68	558.777	17,406	19.90
23	463,320	547,800	33,739	149.38	716.06	835.277	24,757	17.90
24	547,800	488,400	31,152	182.80	898.86	946.922	30,397	19.30
25	488,400	580,800	28,934	155.46	1054.32	892.044	30,830	17.40
26	580,800	731,280	42,135	275.58	1329.90	1139.439	27,043	24.20
27	731,280	1,128,600	31,416	272.02	1601.92	843.387	26,846	32.30
28	1,128,600	1,689,600	51,163	608.60	2210.52	2268.657	44,342	26.80

Table IX
THOMANN MODEL
SEGMENT GEOMETRY POTOMAC ESTUARY
MEAN WATER DATA
(Excluding Embayments)

Segment Number	Interface Areas Upper ft^2	Interface Areas Lower ft^2	Length ft	Volume $ft^3 \times 10^8$	Accumulative Volume $ft^3 \times 10^8$	Surface Area $ft^2 \times 10^6$	Average Width ft	Average Depth ft
1	1,078	42,960	14,890	2.06	2.06	8.332	559	24.7
2	42,960	25,062	10,665	2.77	4.83	13.886	1,302	20.0
3	25,062	24,153	9,187	2.08	6.91	19.218	2,092	10.8
4	24,153	34,815	9,504	2.67	9.58	25.439	2,677	10.5
5	34,815	40,740	8,396	3.23	12.81	24.440	2,911	13.2
6	40,740	37,860	11,404	4.06	16.87	30.883	2,708	13.2
7	37,860	50,760	13,992	6.40	23.27	52.323	3,739	12.2
8	50,760	53,588	11,300	6.31	29.58	47.768	4,227	13.2
9	53,588	66,372	13,516	9.15	38.73	45.769	3,386	20.0
10	66,372	64,654	10,085	7.57	46.30	57.433	5,695	13.2
11	64,654	92,850	13,570	10.37	56.67	55.878	4,118	18.5
12	92,850	108,537	24,129	25.00	81.67	146.860	6,086	17.0
13	108,537	130,350	15,312	19.11	100.78	123.309	8,053	15.5
14	130,350	191,700	14,732	22.03	122.81	182.186	12,368	12.1
15	191,700	165,915	22,387	40.05	162.86	195.516	8,732	20.5
16	165,915	218,250	21,859	42.19	205.05	236.064	10,799	17.9
17	218,250	221,328	22,123	51.36	256.41	374.925	16,950	13.7
18	221,328	224,190	25,291	55.61	312.02	391.366	15,475	14.2
19	224,190	165,060	28,354	51.04	363.06	251.061	8,856	20.3
20	165,060	205,614	24,816	50.06	413.12	327.268	13,186	15.3
21	205,614	248,468	27,614	63.97	477.09	286.387	10,371	22.3

SEGMENT GEOMETRY POTOMAC ESTUARY (Cont.)
MEAN WATER DATA
(Excluding Embayments)

Segment Number	Interface Areas Upper ft^2	Interface Areas Lower ft^2	Length ft	Volume $ft^3 \times 10^8$	Accumulative Volume $ft^3 \times 10^8$	Surface Area $ft^2 \times 10^6$	Average Width ft	Average Depth ft
22	248,408	483,595	32,103	115.50	592.59	558.777	17,406	20.7
23	483,595	574,886	33,739	157.20	749.79	835.277	24,757	18.8
24	574,886	508,966	31,152	192.00	941.79	946.922	30,397	20.2
25	508,966	607,517	28,934	163.70	1105.49	892.044	20,830	18.35
26	607,517	746,890	42,135	285.30	1390.79	1139.439	27,043	25.0
27	746,890	1,156,690	31,416	278.10	1668.89	843.387	26,846	33.0
28	1,156,690	1,724,765	51,163	622.10	2291.00	2268.657	44,342	27.4

Table X
THOMANN MODEL
SEGMENT VOLUMES
(Including Embayments)

Segment Number	Total Volume at Low Water ($ft^3 \times 10^8$)	Total Volume at Mean Water ($ft^3 \times 10^8$)	Accumulative Volume at Low Water ($ft^3 \times 10^8$)	Accumulative Volume at Mean Water ($ft^3 \times 10^8$)
1	1.94	2.06	1.94	2.06
2	2.58	2.77	4.52	4.83
3	2.34	2.70	6.86	7.53
4	9.20	10.21	16.06	17.74
5	3.58	4.02	19.64	21.76
6	4.72	5.34	24.36	27.10
7	7.58	8.82	31.94	35.92
8	6.19	7.01	38.13	42.93
9	9.69	10.68	47.82	53.61
10	7.03	7.71	54.85	61.32
11	10.34	11.09	65.19	72.41
12	26.45	28.62	91.64	101.03
13	18.06	19.11	109.70	120.14
14	30.79	33.99	140.49	154.13
15	46.19	48.78	186.68	202.91
16	41.05	42.76	227.73	245.67
17	49.11	51.36	276.84	297.03
18	59.69	63.02	336.53	360.05
19	49.68	51.04	386.21	411.09
20	52.01	54.50	438.22	465.59
21	71.97	75.03	510.19	540.62

SEGMENT VOLUMES (Cont.)
(Including Embayments

Segment Number	Total Volume at Low Water ($ft^3 \times 10^8$)	Total Volume at Mean Water ($ft^3 \times 10^8$)	Accumulative Volume at Low Water ($ft^3 \times 10^8$)	Accumulative Volume at Mean Water ($ft^3 \times 10^8$)
22	114.92	120.21	625.11	660.82
23	153.49	162.20	778.60	823.03
24	227.98	241.78	1006.58	1064.81
25	189.07	200.92	1195.65	1265.73
26	282.79	293.45	1478.44	1559.18
27	315.76	325.45	1794.20	1884.63
28	619.24	633.84	2413.44	2518.47

Table XI
THOMANN MODEL
REVISED POTOMAC ESTUARY GEOMETRY FOR EXPANDED SEGMENTED SYSTEM
MEAN WATER DATA
(Excluding Embayments)

Segment Number	Interface Areas Upper (ft^2)	Interface Areas Lower (ft^2)	Length (ft)	Volume ($ft^3 \times 10^8$)	Surface Area ($ft^2 \times 10^6$)	Width (ft)	Depth (ft)
1	1078	6630	7814	0.30	3.222	412	9.3
2	6630	42960	7076	1.75	5.110	722	34.2
3	42960	22282	2851	0.93	3.110	1091	29.9
4	22282	23406	4065	0.93	4.560	1122	20.4
5	23406	25062	3749	0.91	6.110	1630	14.9
6	25062	21789	5597	1.31	10.766	1925	12.2
7	21789	24153	3590	0.82	8.443	2352	9.7
8	24153	28676	5439	1.44	15.108	2778	9.5
9	28676	34815	4065	1.29	10.331	2541	12.5
10	34815	43352	1690	0.66	5.110	3024	12.9
11	43352	36996	3696	1.48	10.331	2795	14.3
12	36996	40740	3010	1.17	8.998	2989	13.0
13	40740	32160	6124	2.23	16.663	2721	13.4
14	32160	37860	5280	1.85	14.219	2693	13.0
15	37860	33255	3960	1.41	11.331	2861	12.4
16	33255	57396	3855	1.75	13.775	3573	12.7
17	57396	50760	6177	3.34	25.106	4064	13.3
18	50760	56172	2640	1.41	13.886	5260	10.2
19	56172	58875	5386	3.10	23.106	4290	13.4
20	58875	53588	3274	1.84	10.776	3291	17.1
21	53588	58992	5280	2.97	14.997	2840	19.8

REVISED POTOMAC ESTUARY GEOMETRY FOR EXPANDED SEGMENTED SYSTEM
MEAN WATER DATA (Cont.)
(Excluding Embayments)

Segment Number	Interface Areas Upper (ft^2)	Interface Areas Lower (ft^2)	Length (ft)	Volume ($ft^3 \times 10^8$)	Surface Area ($ft^2 \times 10^6$)	Width (ft)	Depth (ft)
22	58992	87642	3009	2.21	9.220	3064	24.0
23	87642	66372	5227	4.03	21.551	4123	18.7
24	66372	84210	5069	3.82	29.439	5808	13.0
25	84210	64654	5016	3.73	27.994	5581	13.3
26	64654	72693	4805	3.30	19.996	4162	16.5
27	72693	92850	8765	7.25	35.882	4094	20.2
28	92850	97380	9081	8.64	53.656	5909	16.1
29	97380	116509	6706	7.17	42.436	6328	16.9
30	116509	108537	8342	9.39	50.768	6086	18.5
31	108537	129910	5597	6.67	53.767	9606	12.4
32	129910	128000	5650	7.29	38.659	6842	18.9
33	128000	130350	4065	5.25	30.883	7597	12.0
34	130350	136980	6706	8.96	76.429	11397	11.7
35	136980	191700	8026	13.19	105.757	13177	12.5
36	191700	181894	10507	19.63	100.535	9569	19.5
37	181894	165915	13464	23.41	94.981	7054	24.6
38	165915	191334	9715	17.35	88.648	9125	19.5
39	191334	218250	12144	24.87	147.414	12139	16.8
40	218250	246360	10876	25.27	190.184	17486	13.3
41	246360	221328	11246	26.30	187.740	16427	14.2
42	221328	216642	12460	27.29	178.630	14336	15.3

REVISED POTOMAC ESTUARY GEOMETRY FOR EXPANDED SEGMENTED SYSTEM
MEAN WATER DATA (Cont.)
(Excluding Embayments)

Segment Number	Interface Areas Upper (ft^2)	Interface Areas Lower (ft^2)	Length (ft)	Volume ($ft^3 \times 10^8$)	Surface Area ($ft^2 \times 10^6$)	Width (ft)	Depth (ft)
43	216642	224190	12830	28.28	212.735	16581	13.3
44	224190	172892	10824	21.50	126.308	11669	17.0
45	172892	165060	17529	29.60	124.752	7117	23.7
46	165060	214518	10560	20.04	130.196	12330	15.4
47	214518	205614	14256	29.95	197.071	13824	15.2
48	205614	236645	12936	28.61	164.189	12685	17.4
49	236645	248468	12038	29.20	122.197	10151	23.9
50	248468	258192	9820	24.88	107.200	10916	23.2
51	258192	444206	6441	22.62	190.184	29526	11.9
52	444206	483595	10560	48.99	261.392	24753	18.7
53	483595	328522	9451	38.38	164.411	17396	23.3
54	328522	548750	6811	29.88	337.154	49501	8.9
55	548750	574886	10665	59.92	333.711	31290	18.0
56	574886	690598	10137	64.14	316.381	31210	20.3
57	690598	640497	8712	57.98	256.948	29494	22.6
58	640497	508966	12302	70.70	373.591	30368	18.9
59	508966	550744	10612	56.23	264.947	24967	21.2
60	550744	608974	11616	67.36	314.937	27113	21.4
61	608974	607517	6705	40.78	312.159	46556	13.1
62	607517	616704	8712	53.33	233.953	26854	22.8
63	616704	644292	8659	54.59	288.831	33356	18.9

REVISED POTOMAC ESTUARY GEOMETRY FOR EXPANDED SEGMENTED SYSTEM
MEAN WATER DATA (Cont.)
(Excluding Embayments)

Segment Number	Interface Areas Upper (ft^2)	Interface Areas Lower (ft^2)	Length (ft)	Volume ($ft^3 \times 10^8$)	Surface Area ($ft^2 \times 10^6$)	Width (ft)	Depth (ft)
64	644292	724601	8659	59.27	270.834	31277	21.9
65	724601	746890	16104	118.48	345.819	21474	34.3
66	746890	858496	10560	84.66	262.058	24816	32.3
67	858496	857947	10348	88.81	257.615	24896	34.5
68	857947	1156690	10507	109.84	323.713	30809	32.7
69	1156690	1144810	11352	130.63	421.026	37087	31.0
70	1144810	1182700	10560	122.89	403.030	36166	30.5
71	1182720	1162709	11140	130.64	367.704	32992	35.5
72	1162709	1198613	8448	99.74	310.604	36766	32.1
73	1198613	1724765	9662	141.23	766.291	79309	18.4

A25

Table XII

MATHEMATICAL MODEL SEGMENTATION
Anacostia Tidal River System
Mean Water Data*

Segment Number	Interface Areas Upper (ft^2)	Interface Areas Lower (ft^2)	Interface Widths Upper (ft)	Interface Widths Lower (ft)	Length (ft)	Volume ($ft^3 \times 10^6$)	Surface Area ($ft^2 \times 10^6$)	Depth (ft)
1	31,290	58,060	1500	3200	2900	129.55	4.96	26.11
2	27,100	31,290	1250	1500	2380	69.48	3.24	21.44
3	27,100	27,100	1250	1250	2380	64.49	2.68	24.06
4	24,710	27,100	1150	1250	2640	68.38	3.20	21.36
5	14,450	24,710	750	1150	2640	51.69	2.36	21.90
6	8,580	14,450	750	750	3430	39.84	2.80	14.22
7	8,645	8,580	750	750	3430	29.53	2.44	12.10
8	3,095	8,645	550	750	3170	18.60	1.76	10.56
9	4,805	3,095	400	550	2900	11.45	1.36	8.41
10	2,840	4,805	350	400	3960	15.13	1.32	11.46
11	3,195	2,840	300	350	3170	9.56	1.00	9.56
12	3,000	3,195	300	300	3430	10.62	1.04	10.21
13	3,030	3,000	250	300	2900	8.74	0.80	10.92
14	1,775	3,030	250	250	2640	6.34	0.60	10.57
15	775	1,775	200	250	2640	5.20**	1.00	5.20

* Data based on soundings made April 1970

** Volume of Marina = 1500 ft x 2710 ft^2 = 4.06 x 10^6 ft^3

C33

Table XIII
FWQA NETWORK DATA
POTOMAC ESTUARY
(Excluding Embayments)

	Node	Cross-sectional Area at Node (ft)	Average Depth at Node (ft)	Surface Area (ft^2)	Channel		Length (ft)	Average Cross-sectional Area (ft^2)	Average Depth (ft)
Chain Br.	114	1000	17.8	888711	01	66-02	7814	3500	15.6
	02	6000	13.3	4332467	02	02-03	7076	23850	29.8
	03	41700	46.3	4665733	03	03-04	2851	31230	32.7
	04	20760	19.1	4443556	04	04-05	4065	21180	17.9
	05	21600	16.7	4665733	05	05-06	3749	22050	14.5
	06	22500	12.3	8442756	06	06-07	5597	20622	10.6
	07	18744	9.0	8887111	07	07-08	3590	19502	8.3
	08	20260	7.6	12886311	08	08-09	5439	22130	7.6
	09	24000	7.5	13219578	09	09-10	4065	27450	9.4
	10	30900	11.4	8664933	10	10-11	1690	34840	11.8
	11	38780	12.3	7109689	11	11-12	3696	35515	10.9
	12	32250	9.5	9442556	12	12-13	3010	33975	9.7
	13	35700	9.9	15552445	13	13-14	6124	32670	13.2
	14	29640	16.5	12886311	14	14-15	5280	31020	12.4
	15	42400	8.3	13775022	15	15-16	3960	30600	8.5
	16	28800	8.7	12664133	16	16-17	3855	40365	10.8
	17	51930	12.8	19773822	17	17-18	6177	47640	10.2
	18	43350	7.6	22884311	18	18-19	2640	46250	8.4
	19	49150	9.1	19329467	19	19-20	5386	51875	12.6
	20	54600	16.0	15552445	20	20-21	3274	52050	15.6
	21	49500	15.1	13108489	21	21-22	5280	52500	17.2

FWQA NETWORK DATA
POTOMAC ESTUARY (Cont.)
(Excluding Embayments)

Node	Cross-sectional Area at Node (ft)	Average Depth at Node (ft)	Surface Area (ft^2)	Channel		Length (ft)	Average Cross-sectional Area (ft^2)	Average Depth (ft)
22	55500	19.2	10775622	22	22-23	3009	69365	20.9
23	83230	22.6	14441556	23	23-24	5227	71765	17.0
24	60300	11.4	26772422	24	24-25	5069	68625	11.5
25	76950	11.6	29216378	25	25-26	5016	68550	12.8
26	60150	14.0	23661934	26	26-27	4805	64060	14.6
27	67970	15.1	29327467	27	27-28	8765	77110	14.1
28	86250	13.1	42769223	28	28-29	9081	88500	13.4
29	90750	13.7	53878112	29	29-30	6706	100815	16.2
30	110880	18.7	47990400	30	30-31	8342	105240	14.4
31	99600	10.0	49323467	31	31-32	5597	111300	12.6
32	123000	15.1	53544845	32	32-33	5650	122500	16.2
33	122000	17.3	43324667	33	33-34	4065	122575	15.5
34	123150	13.7	59099289	34	34-35	6706	125325	12.2
35	127500	10.8	81094890	35	35-36	8026	153600	11.4
36	179700	12.0	120531446	36	36-37	10507	177900	17.4
37	176100	22.8	92648134	37	37-38	13464	168225	21.5
38	160350	20.2	83983201	38	38-39	9715	172425	19.3
39	184500	18.4	119976001	39	39-40	12144	196500	16.2
40	208500	13.9	174965002	40	40-41	10876	221850	13.2
41	235200	12.6	190184180	41	41-42	11246	223800	13.4
42	212400	14.3	184963002	42	42-43	12460	210450	14.7

FWQA NETWORK DATA
POTOMAC ESTUARY (Cont.)
(Excluding Embayments)

Node	Cross-sectional Area at Node (ft)	Average Depth at Node (ft)	Surface Area (ft^2)	Channel		Length (ft)	Average Cross-sectional Area (ft^2)	Average Depth (ft)
43	208500	15.1	166300068	43	43-44	12830	212550	15.4
44	216600	15.7	209735824	44	44-45	10824	192300	17.3
45	168000	18.9	121420157	45	45-46	17529	164700	20.4
46	161400	22.0	219956002	46	46-47	10560	183900	18.0
47	206400	14.0	186296069	47	47-48	14256	292650	15.9
48	198900	17.8	172187780	48	48-49	12936	213750	18.0
49	228600	18.1	156524246	49	49-50	12038	235300	22.2
50	242000	26.2	102646134	50	50-51	9820	245740	23.8
51	249480	21.5	168077491	51	51-52	6441	336600	19.0
52	423720	16.5	235286269	52	52-53	10560	443520	17.4
53	463320	18.3	215845713	53	53-54	9451	388740	17.9
54	314160	17.5	193294669	54	54-55	6811	418440	17.3
55	522720	17.1	291719425	55	55-56	10665	535260	17.6
56	547800	18.2	320047092	56	56-57	10137	603900	19.4
57	660000	20.5	349818915	57	57-58	8712	634260	19.2
58	608520	18.0	371925604	58	58-59	12302	548460	20.3
59	488400	22.6	268724025	59	59-60	10612	504900	19.8
60	521400	16.9	325490448	60	60-61	11616	552420	19.0
61	583440	21.2	246839514	61	61-62	6705	582120	20.6
62	580800	20.0	225954802	62	62-63	8712	586740	21.2
63	592680	22.4	241396158	63	63-64	8659	607200	23.6

FWQA NETWORK DATA
POTOMAC ESTUARY (Cont.)
(Excluding Embayments)

	Node	Cross-sectional Area at Node (ft)	Average Depth at Node (ft)	Surface Area (ft^2)	Channel		Length (ft)	Average Cross-sectional Area (ft^2)	Average Depth (ft)
	64	621720	24.8	293052492	64	64-65	8659	663300	27.2
	65	704880	29.6	276944603	65	65-01	16104	718080	31.9
Piney Pt.	66	731280	34.2	336154981	66	01-67	10560	786720	34.6

Table XIV
EMBAYMENT DATA - POTOMAC ESTUARY

Name	Segment	Surface Area ($ft^2 \times 10^6$)	Average Depth at Low Water (ft)	Volume at Low Water ($ft^3 \times 10^8$)	Average Depth at Mean Water (ft)	Volume at Mean Water ($ft^3 \times 10^8$)	Location (Miles below Chain Bridge)
Columbia Island Channel	3	2.555	5.0	0.13	6.40	0.16	4.65 - 5.76
Tidal Basin	3	4.444	9.0	0.40	10.40	0.46	5.81
Washington Channel	4	8.109	23.0	1.86	24.45	1.98	-
Anacostia River	4	35.993	14.0	5.04	15.45	5.56	7.60 - 8.20
Four Mile (Hunter Pt.)	5	6.332	11.0	0.70	12.45	0.79	8.79 - 9.70
Oxon Creek (Upper)	6	13.664	8.0	1.09	9.40	1.28	10.55 - 12.13
Oxon Creek (Lower)	7	18.330	8.0	1.47	9.35	1.71	12.13 - 13.57
Hunting Creek	7	21.218	2.0	0.42	3.35	0.71	12.13 - 13.50
Broad Creek	8	16.219	3.0	0.49	4.30	0.70	14.90 - 15.92
Piscataway Creek	9	36.437	3.0	1.09	4.20	1.53	18.11 - 18.63
Little Hunting Creek	10	4.444	2.0	0.09	3.10	0.14	19.90 - 20.33
Dogue Creek	11	17.885	3.0	0.54	4.05	0.72	21.85 - 22.80
Gunston Cove	12	65.431	4.0	2.62	5.00	3.27	24.02 - 25.42
Pomonkey Creek	12	8.776	3.0	0.26	3.95	0.35	26.73 - 27.10
Belmont Bay	14	69.431	4.0	2.78	4.80	3.33	-
Occoquan Bay	14	148.859	5.0	7.44	5.80	8.63	31.45 - 34.09
Powells Creek	15	19.218	2.0	0.38	2.80	0.54	34.79 - 35.92
Mattawoman Creek	15	74.541	8.0	5.96	8.80	6.56	34.13 - 35.60
Quantico Creek	15	29.327	2.0	0.59	2.70	0.79	38.10 - 38.55
Chicamuxen Creek	15	22.773	3.0	0.68	3.70	0.84	36.91 - 37.75
Chopawamsic Creek	16	13.553	2.0	0.27	2.67	0.36	40.75

EMBAYMENT DATA - POTOMAC ESTUARY (Cont.)

Name	Segment	Surface Area ($ft^2 \times 10^6$)	Average Depth at Low Water (ft)	Volume at Low Water ($ft^3 \times 10^8$)	Average Depth at Mean Water (ft)	Volume at Mean Water ($ft^3 \times 10^8$)	Location (Miles below Chain Bridge)
Mallows Bay	16	4.444	4.0	0.18	4.65	0.21	41.64 - 42.44
Aquia Creek	18	101.091	4.0	4.04	4.60	4.65	46.89 - 48.40
Potomac Creek	18	76.985	3.0	2.31	3.58	2.76	49.20 - 49.70
Nanjemoy Creek	20	124.975	3.0	3.75	3.55	4.44	58.18 - 59.20
Port Tobacco River	21	163.856	6.0	9.83	6.75	11.06	62.00 - 63.80
Upper Machodoc Creek	22	71.736	5.0	3.59	5.80	4.16	69.45 - 71.32
Rosier Creek	22	14.442	3.0	0.43	3.80	0.55	72.60 - 73.27
Cuckold Creek	23	16.663	2.0	0.33	2.80	0.47	72.00 - 72.21
Monroe Creek	23	18.552	3.0	0.56	3.80	0 70	-
Mattox Creek	23	61.988	5.0	3.10	5.80	3.60	75.98 - 77.32
Popes Creek	23	12.442	1.0	0.12	1.85	0.23	79.15
Wicomico River	24	389.367	9.0	35.04	9.92	38.62	80.52 - 82.85
St. Clement Bay	25	154.080	9.0	13.87	9.90	15.25	86.05 - 88.35
Breton Bay	25	135.306	9.0	12.18	9.90	13.40	89.36 - 90.20
Nomini Bay	25	126.086	6.0	7.56	6.80	8.57	87.26 - 89.48
Lower Machodoc Creek	26	92.648	7.0	6.48	7.85	7.27	91.15 - 93.38
Herring Creek	26	18.330	4.0	0.73	4.80	0.88	96.10
St. Georges Creek	27	77.318	5.0	3.87	5.75	4.45	-
St. Mary's River	27	285.165	11.0	31.37	11.75	33.51	102.96 -104.35
Yeocomico River	27	141.638	6.0	8.50	6.63	9.39	103.80 -104.65
Smith Creek	28	48.657	7.0	3.40	7.75	3.77	105.15 -106.65
Coan River	28	100.424	6.0	6.02	6.60	6.63	107.20 -109.00
Hull Creek	28	20.329	6.0	1.22	6.60	1.34	113.00

TABLE XV

MATHEMATICAL MODEL PLOTTING POSITIONS FOR
MAIN STEM OF POTOMAC ESTUARY

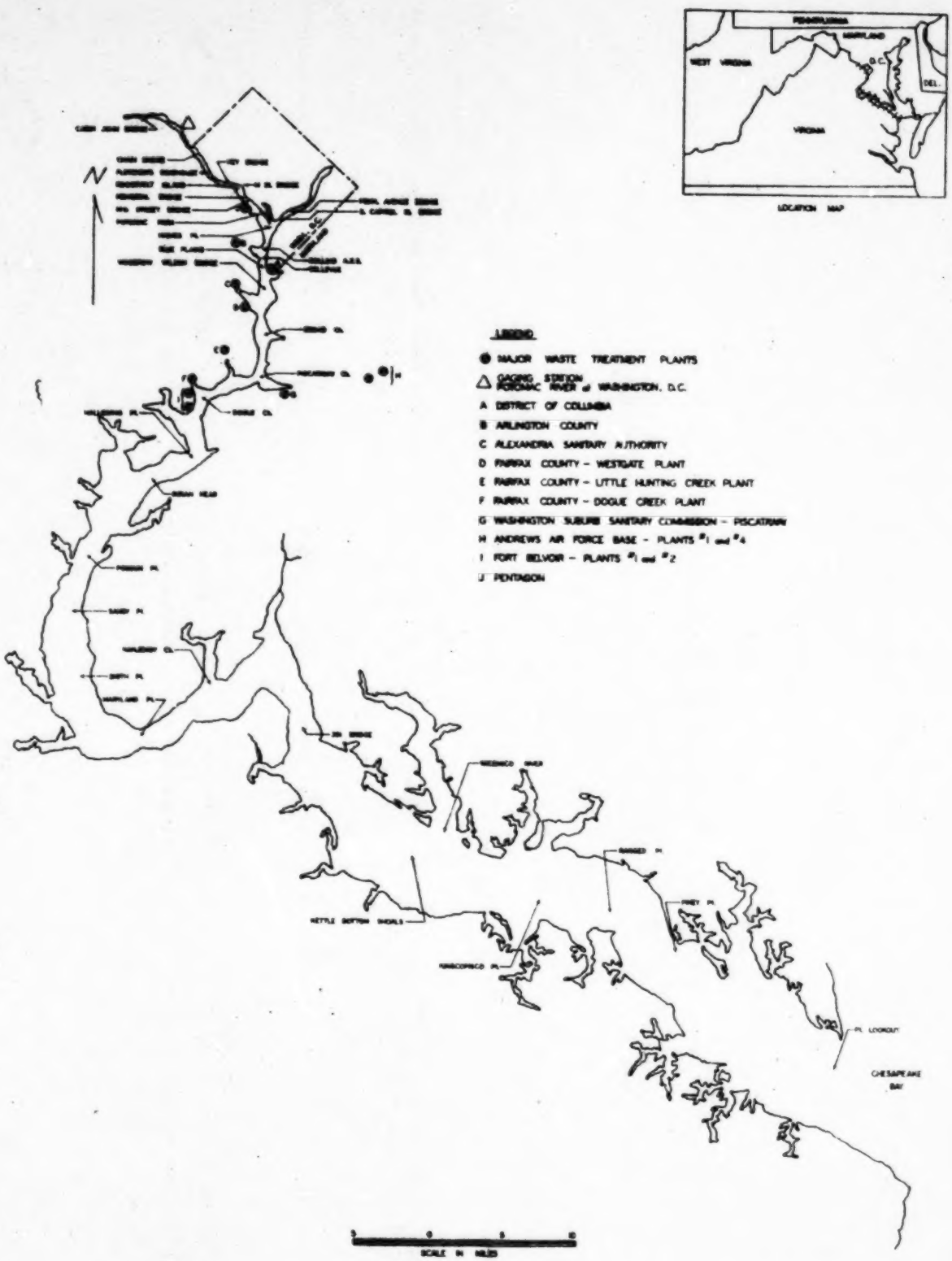
Segment Number	Thomann Model (miles)	FWQA Model (miles)
1	0.74	0*
2	2.15	1.48
3	3.09	2.82
4	3.74	3.30
5	4.48	4.13
6	5.37	4.83
7	6.24	5.90
8	7.10	6.57
9	8.00	7.61
10	8.54	8.37
11	9.05	8.70
12	9.68	9.40
13	10.55	9.97
14	11.63	11.12
15	12.50	12.12
16	13.24	12.87
17	14.20	13.61
18	15.03	14.77

* Junction 114

Segment Number	Thomann Model (miles)	FWQA Model (miles)
19	15.79	15.27
20	16.61	16.30
21	17.42	16.92
22	18.20	17.92
23	18.98	18.48
24	19.96	19.47
25	20.92	20.44
26	21.84	21.39
27	28.13	22.30
28	24.82	23.96
29	26.32	25.67
30	27.74	26.95
31	29.06	28.52
32	30.12	29.58
33	31.04	30.66
34	32.06	31.42
35	33.46	32.70
36	35.26	34.22
37	37.34	36.21
38	39.38	38.76
39	41.45	40.60
40	43.63	42.90

Segment Number	Thomann Model (miles)	FWQA Model (miles)
41	45.73	44.95
42	47.97	47.08
43	50.37	49.44
44	52.11	51.87
45	55.29	53.92
46	57.95	57.24
47	60.30	59.24
48	62.88	61.94
49	66.24	64.39
50	67.82	66.67
51	69.35	68.53
52	71.96	69.75
53	73.85	71.75
54	76.04	73.54
55	78.34	74.83
56	80.31	76.85
57	82.13	78.77
58	84.09	80.42
59	86.26	82.75
60	88.36	84.76

Segment Number	Thomann Model (miles)	FWQA Model (miles)
61	90.10	86.96
62	91.56	88.23
63	93.20	89.88
64	96.48	91.52
65	97.19	93.16
66	99.71	96.21
67	101.89	98.21
68	103.67	100.17
69	105.83	102.16
70	107.81	104.31
71	109.87	106.31
72	111.72	108.42
73	113.84	110.02


LOCATION MAP
LEGEND
MAJOR WASTE TREATMENT PLANTS
GAGING STATION POTOMAC RIVER at WASHINGTON, D.C.
A DISTRICT OF COLUMBIA
B ARLINGTON COUNTY
C ALEXANDRIA SANITARY AUTHORITY
D FAIRFAX COUNTY - WESTGATE PLANT
E FAIRFAX COUNTY - LITTLE HUNTING CREEK PLANT
F FAIRFAX COUNTY - DOGUE CREEK PLANT
G WASHINGTON SUBURBS SANITARY COMMISSION - PISCATAWAY
H ANDREWS AIR FORCE BASE - PLANTS #1 and #4
I FORT BELVOIR - PLANTS #1 and #2
J PENTAGON
N
SCALE IN MILES
CHESAPEAKE BAY

POTOMAC ESTUARY
SAMPLING STATIONS

44<

FIGURE III

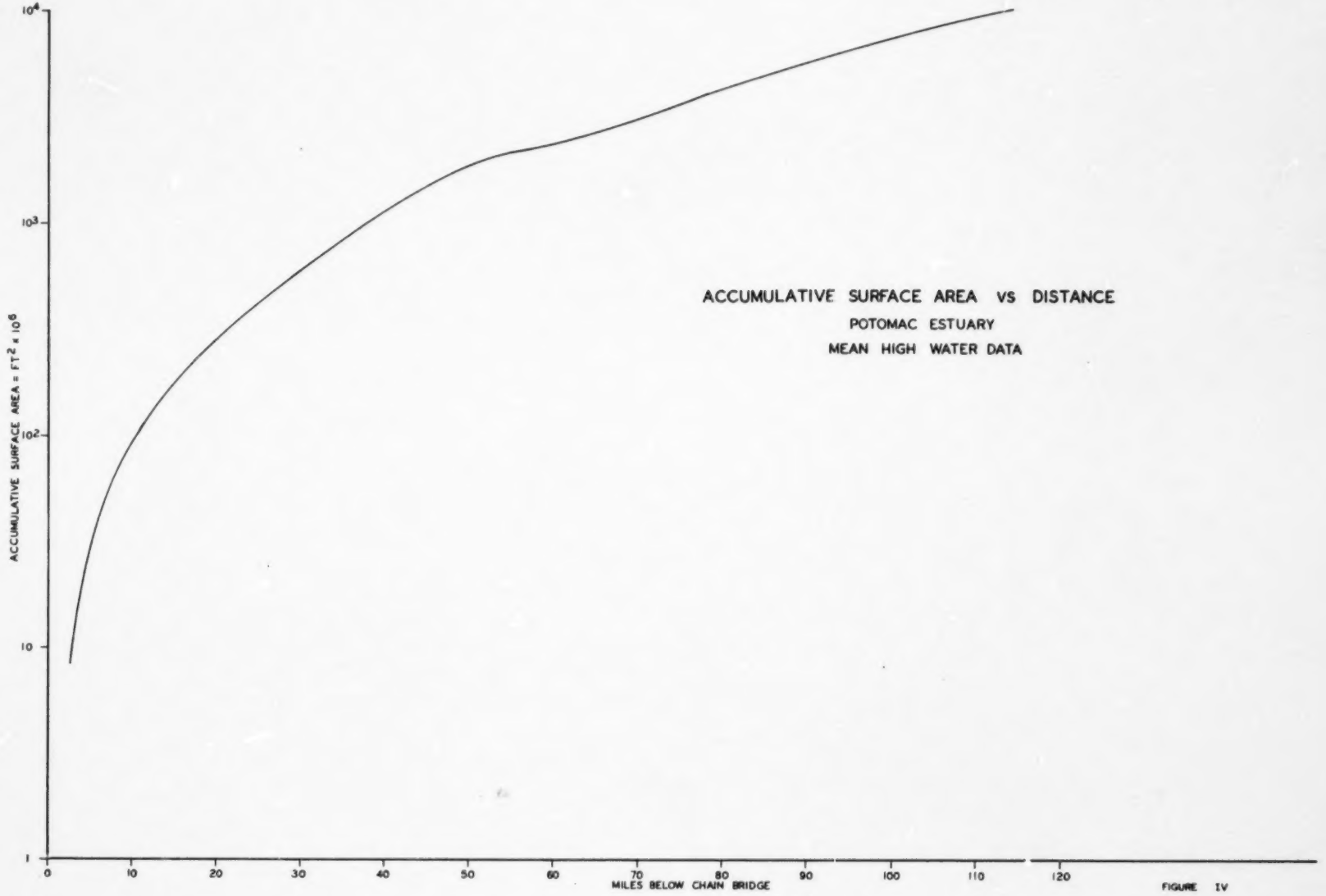
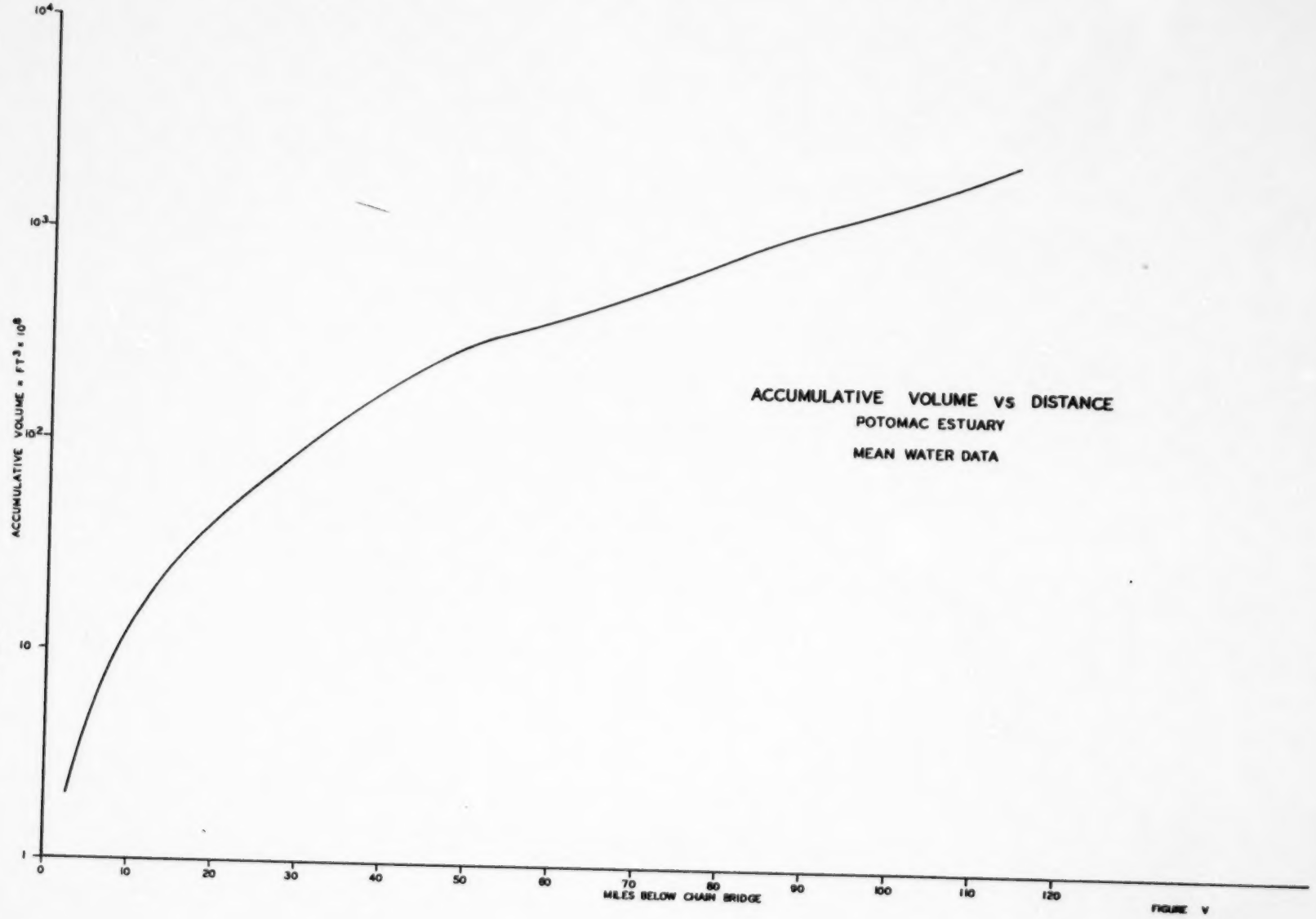

ACCUMULATIVE SURFACE AREA VS DISTANCE
POTOMAC ESTUARY
MEAN HIGH WATER DATA
ACCUMULATIVE SURFACE AREA = FT² x 10⁶
10⁴
10³
10²
10
1
0
10
20
30
40
50
60
70
80
90
100
110
120
MILES BELOW CHAIN BRIDGE

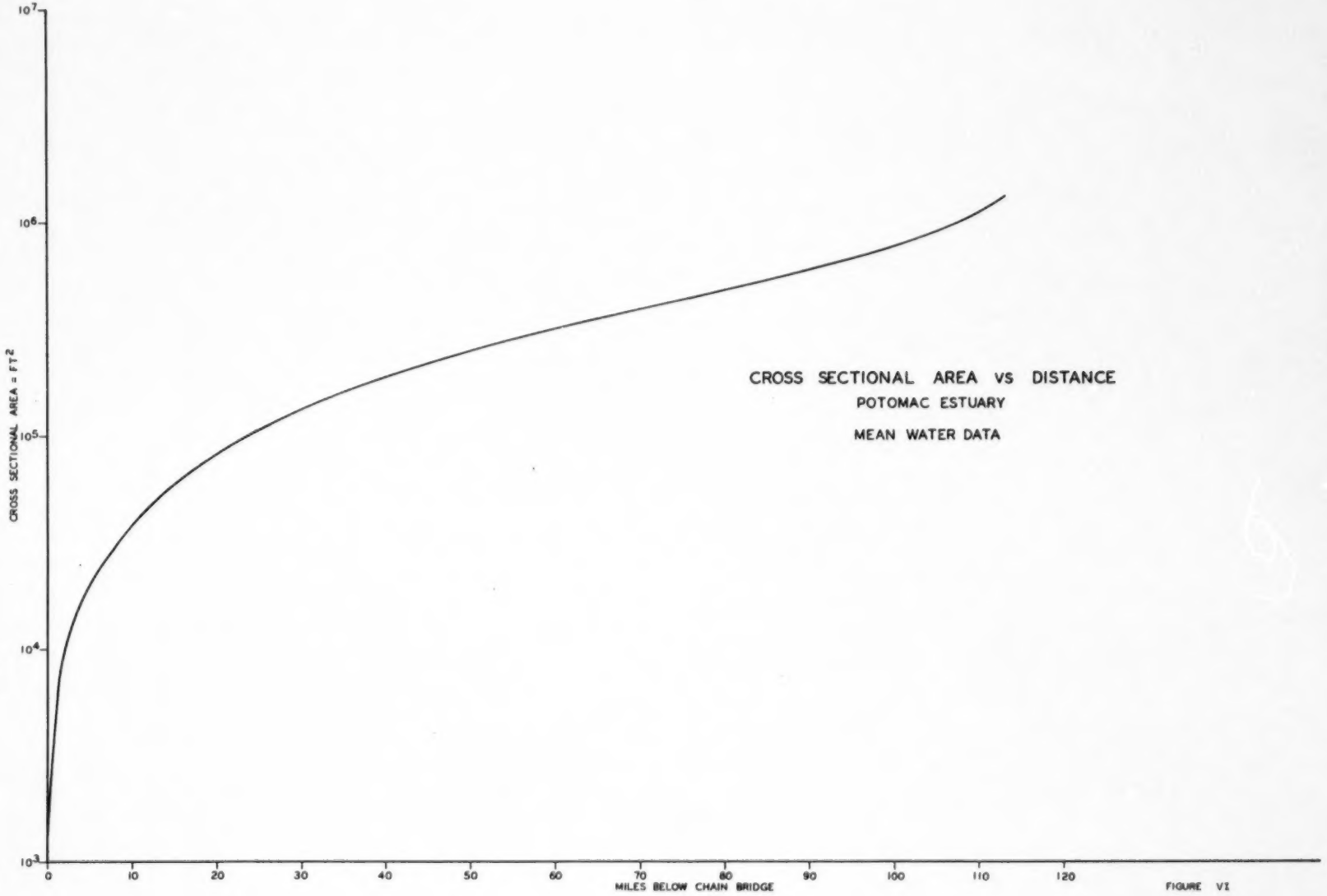
FIGURE IV



ACCUMULATIVE VOLUME VS DISTANCE
POTOMAC ESTUARY
MEAN WATER DATA

FIGURE V

>97

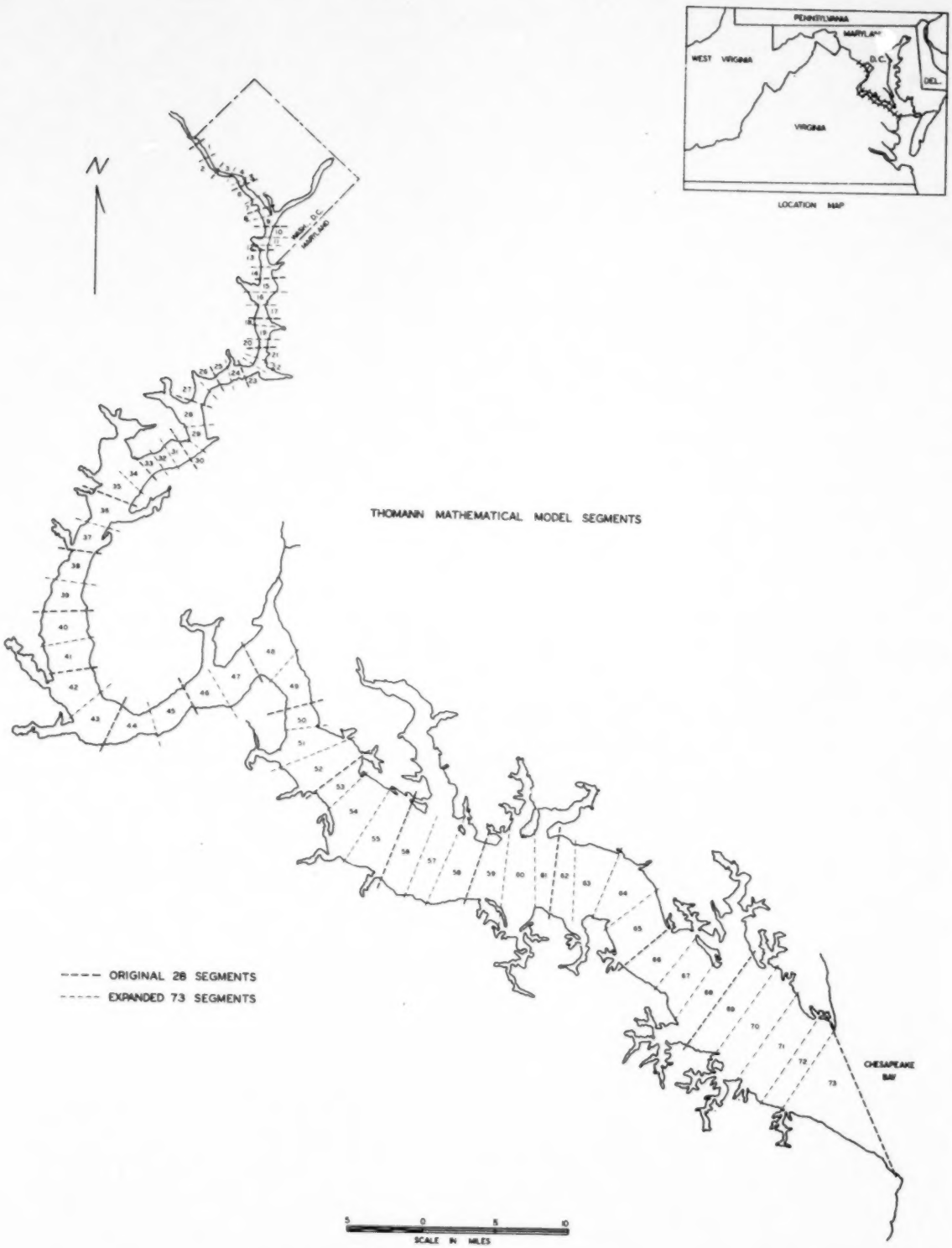


CROSS SECTIONAL AREA vs DISTANCE

POTOMAC ESTUARY

MEAN WATER DATA

FIGURE VI



POTOMAC ESTUARY

FIGURE VII

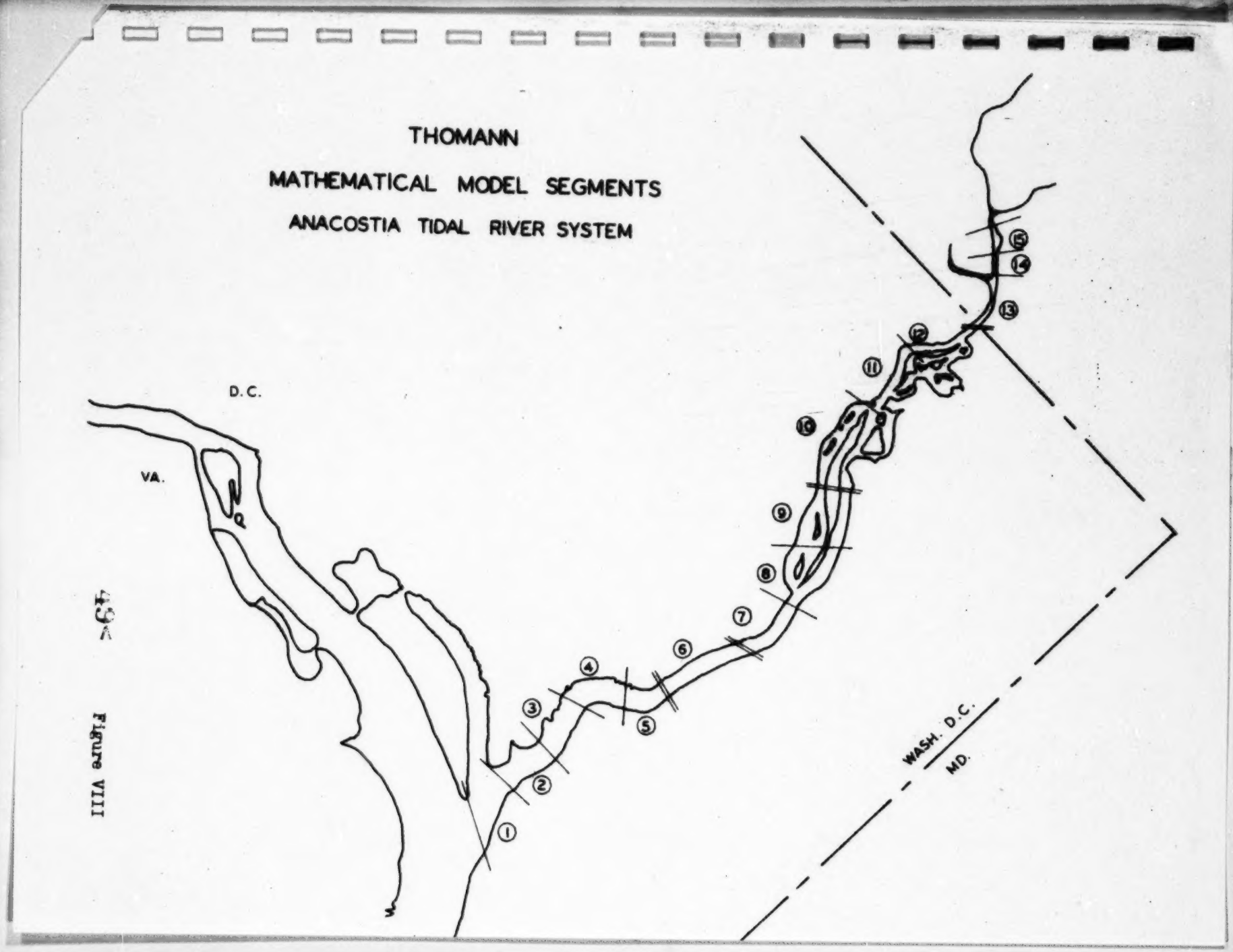
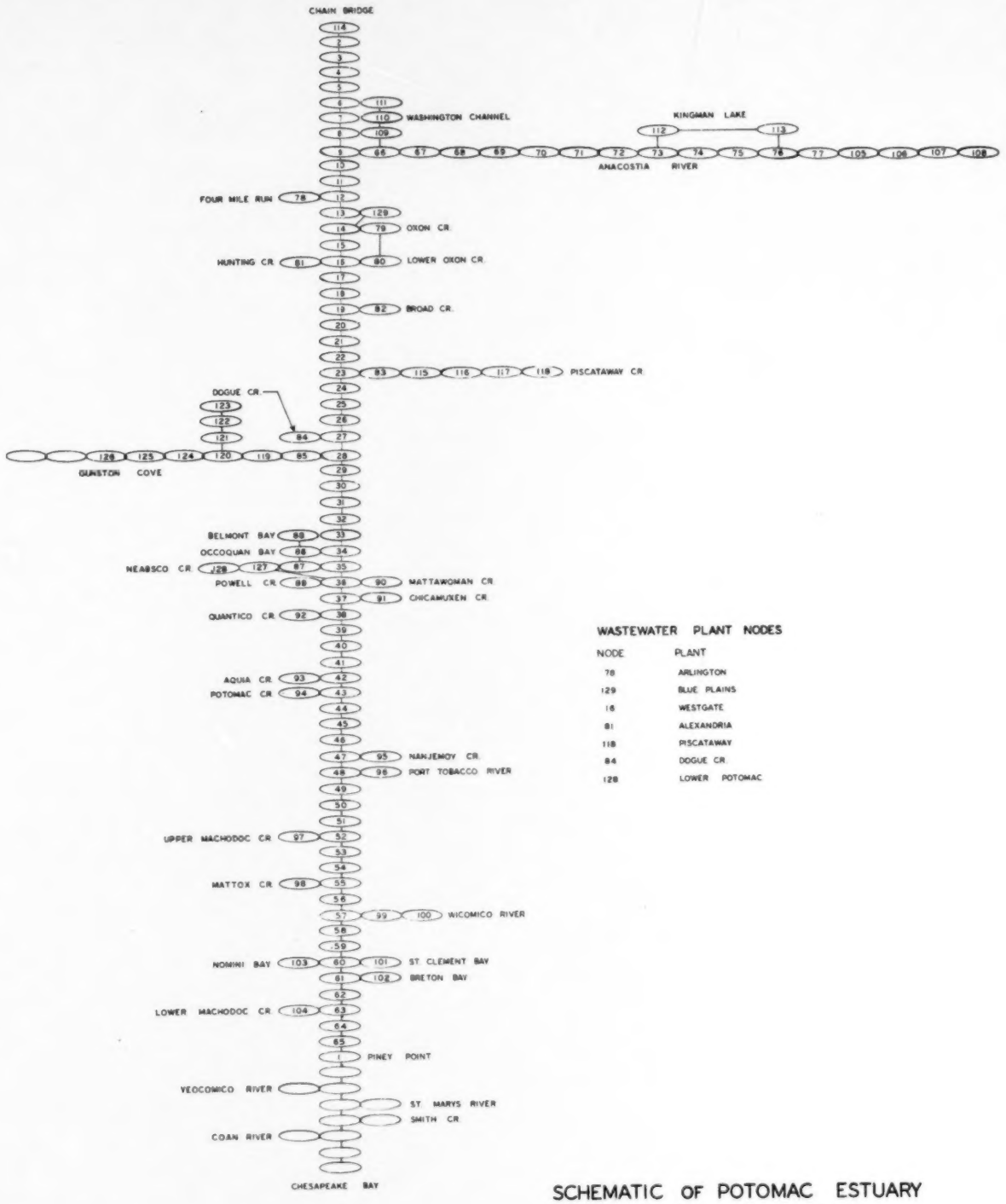

THOMANN
MATHEMATICAL MODEL SEGMENTS
ANACOSTIA TIDAL RIVER SYSTEM
D.C.
VA.
WASH. D.C.
MD.
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15

Figure VIII



WASTEWATER PLANT NODES

NODE	PLANT
78	ARLINGTON
129	BLUE PLAINS
16	WESTGATE
81	ALEXANDRIA
118	PISCATAWAY
84	DOGUE CR.
128	LOWER POTOMAC

SCHEMATIC OF POTOMAC ESTUARY
FOR FWQA DYNAMIC MODEL

FIGURE IX